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NEW AND UNUSUAL SPECIES OF
BRACHIOPODS FROM THE ARBUCKLE
GROUP IN OKLAHOMA

(WITH FOUR PLATES)

BY
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The brachiopods described herein resulted from collecting by Dr. William E. Ham during the detailed mapping of the Arbuckle Mountains. As might be expected, the great care taken by Dr. Ham during the mapping to locate useful and easily recognizable fossils produced a number of new species and others that had hitherto not been seen in this region. Many of the occurrences produced beautifully silicified specimens which make possible easy recovery of excellent study material.

Since the appearance of Ulrich and Cooper's study of the Ozarkian and Canadian Brachiopoda, the stratigraphic sequence of the Arbuckle Mountains has been better defined by Decker (1939) and the brachiopods can now be assigned to their proper formations. The lists below include already known species and those described in this paper.

FORT SILL FORMATION :

Billingsella corrugata Ulrich and Cooper.

Plectotrophia bridgei Ulrich and Cooper.

laticosta Cooper, new species.

Mcsonomia magna Cooper, new species.

SIGNAL MOUNTAIN FORMATION :

Apheoorthis ornata Ulrich and Cooper.

oklahomensis Ulrich and Cooper.

platys Cooper, new species.

Billingsella rectangulata Cooper, new species.

Cymbithyris hami Cooper, new genus and species.

Fasciculina fasciculata Cooper, new genus and species.

Finkclenburgia auriculata Cooper, new species.

biconvexa Cooper, new species.

extensa Cooper, new species.

Palaeostrophia cf. *P. clax* (Clark).

Glyptotrophia rotunda Cooper, new species.

McKENZIE HILL FORMATION:

Finkelburgia arbutclensis Cooper, new species.
cf. *F. bellatula* Ulrich and Cooper.
obesa Cloud.

Syntrophina campbelli (Walcott).

Tetralobula texana Ulrich and Cooper.

COOL CREEK FORMATION:

Finkelburgia delicatula Cooper, new species.
subquadrata Cooper, new species.

Imbricatia lamellata Cooper, new genus and species.

Clarkella species.

Diaphelasma oklahomense Ulrich and Cooper.

Syntrophinella deckeri Cloud.

KINDBLADE FORMATION:

Finkelburgia crassicostellata Cooper, new species.
cullisoni Ulrich and Cooper.
scenidioides Ulrich and Cooper.

Tritoechia delicatula Ulrich and Cooper.

subaequiradiata Ulrich and Cooper.
typica (Ulrich).

Oligorthis arbutclensis Ulrich and Cooper.

Diparelasma fasciculatum Cooper, new species.

WEST SPRING CREEK FORMATION:

Diparelasma costellatum Cooper, new species.
typicum Ulrich and Cooper.

Polytoechia subrotunda Ulrich and Cooper.
subcircularis Cooper, new species.

Pomatotrema magnum Ulrich and Cooper.
oklahomense Ulrich and Cooper.
transversum Ulrich and Cooper.

Syntrophopsis laevicula Ulrich and Cooper.
magna Ulrich and Cooper.

Finkelburgia magna Ulrich and Cooper.

Tritoechia planodorsata Ulrich and Cooper.

Genus **APHEOORTHIS** Ulrich and Cooper, 1936

APHEOORTHIS PLATYS Cooper, new species

Plate 2B, figures 8-13

Shell small for the genus, wider than long, and subrectangular in outline; hinge forming the greatest width; cardinal extremities slightly auriculate. Sides nearly straight; anterior margin broadly rounded. Surface fascicostellate.

Pedicle valve gently convex in lateral profile and with the greatest curvature just anterior to the umbo; anterior profile broadly convex

but with the median region somewhat narrowly convex; beak small; umbo narrowly convex. Fold marked by a median and two lateral fascicles, broad and low. Median region from umbo to anterior margin moderately swollen; flanks descending by a long, moderately steep slope to the margins. Interior with strong dental plates but only slightly thickened muscle area to form a spondylium discretum or the incipient stages of a pseudospondylium.

Brachial valve slightly convex in lateral profile and broadly but gently convex in anterior profile. Umbo smooth and slightly swollen; sulcus originating just anterior to umbo and widening and deepening to the anterior margin where it occupies one-third the valve width. Flanks gently swollen; slopes to posterolateral extremities short and gentle; cardinal extremities flattened. Interior with strong median ridge, small simple cardinal process on a moderately thickened notothyrial platform; brachiophores short and stout; adductor scars strongly impressed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116737a.....	9.0	?	9.8	10.0	2.2
Brachial valve, U.S.N.M. No. 116736b.....	?	7.0	9.6	9.4	0.9

Types.—Holotype: U.S.N.M. No. 116737a; paratype: U.S.N.M. No. 116736b.

Horizon and locality.—Signal Mountain formation (50 feet below the top) in Oklahoma, 2,100 feet north and 1,000 feet west of the southeast corner of sec. 26, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by a fairly flat brachial valve, moderately convex pedicle valve and somewhat subdued ornamentation. This latter feature distinguishes this species from described species. Its ornamentation is much more subdued than that of *A. ornata* Ulrich and Cooper from the same formation.

Genus **BILLINGSSELLA** Hall, 1892

BILLINGSSELLA RECTANGULATA Cooper, new species

Plate 1A, figures 1-15

Shell moderately large for the genus, wider than long, subrectangular in outline. Hinge as wide as or slightly wider than the mid-width; cardinal extremities slightly auriculate; sides nearly straight; anterior margin broadly rounded; surface somewhat fascicostellate.

Pedicle valve nearly flat in the median region in lateral profile but with the umbonal and anterior marginal regions somewhat narrowly convex; anterior profile nearly flat to broadly and gently convex; umbo narrowly convex, the convexity continued to about the valve middle where it fades into the shell surface or slightly anterior to the middle: anteromedian region flattened; anteromarginal region gently but abruptly convex where a shallow, poorly defined sulcus appears; flanks bounding fold gently concave to nearly flat. Interarea orthocline; pseudodeltidium wide and strongly convex. Teeth strong, buttressed by excess shell suggesting short dental plates; adductor track moderately thickened anteriorly; pallial marks moderately strong.

Brachial valve deeper than the pedicle one, gently convex in lateral profile; broadly and moderately convex in anterior profile; umbo sulcate, sulcus wide and moderately deep to the valve middle but becoming shallow and even, or almost so, with the flanks at the front margin. Posterolateral areas flattened and with short steep slopes; flanks bounding sulcus moderately swollen. Interior with short, stout median ridge, lightly developed notothyrial platform and slender cardinal process. Chilidium only moderately developed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
U.S.N.M. No. 116722a.....	12.0	10.2	14.3	14.4	3.9
U.S.N.M. No. 116722b.....	13.5	11.0	14.8	14.9	4.3
U.S.N.M. No. 116722c.....	12.1	9.7	13.9	14.3	3.8

Types.—Holotype: U.S.N.M. No. 116722a; figured paratypes: U.S.N.M. Nos. 116722b, d, e, h, i, k; unfigured paratypes: U.S.N.M. Nos. 116722c, f, g, j.

Horizon and locality.—Signal Mountain formation (1-foot bed of limestone 100 feet above the base) in Oklahoma, 1,700 feet east and 1,300 feet north of the southwest corner of sec. 21, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by its large size, rectangular outline, and moderately short interarea. The specimens illustrated are unusual in showing both valves in contact. *Billingsella* is generally loosely articulated and the valves fall apart after death.

Billingsella rectangulata is larger and squarer than *B. coloradoensis* and is differently ornamented. It approaches *B. corrugata* Ulrich and Cooper in size but lacks the concentric corrugations and acute cardinal extremities of that species.

CYMBITHYRIS Cooper, new genus

Shell attaining a width of about a half inch, wider than long, and with a wide hinge. Profile concavo-convex. Valves of unequal depth, the pedicle valve having the greater depth. Surface multicostellate.

Pedicle valve with pseudodeltidium and foramen as in *Billingsella*; teeth small, dental plates absent; musculature as in *Billingsella*.

Brachial interior with small flat brachiophores like those of *Billingsella*; median ridge short and low; cardinal process a simple ridge. Chilidium well developed.

Genotype.—*Cymbithyris hami* Cooper, new species.

Discussion.—The nearest relative to this genus is *Billingsella*. The two genera have the same type of pseudodeltidium, teeth, and muscular arrangement in the pedicle valve. They differ in that *Cymbithyris* has a concave brachial valve. The brachiophores are like those of *Billingsella* but other details of the brachial interior are obscure. *Cymbithyris* is thus a lateral development from *Billingsella*.

CYMBITHYRIS HAMI Cooper, new species

Plate 1B, figures 16-21

Shell subrectangular to quadrate in outline; hinge wider than mid-width; cardinal extremities somewhat auriculate; sides oblique; anterior margin narrowly rounded. Surface multicostellate.

Pedicle valve strongly convex in lateral profile; anterior profile narrowly convex in the median region and with steep lateral slopes. Umbo narrowly convex, the convexity extending to about the middle where it is dissipated in the median swelling of the valve; median region swollen, the broad swelling extending to the front margin. Flanks moderately swollen and with long, moderately steep slopes to the sides; posterolateral extremities somewhat flattened. Interarea moderately long, orthocline.

Brachial valve fairly concave in anterior and lateral profiles; umbo sulcate, sulcus extending from umbo to front margin, expanding anteriorly; flanks bounding sulcus moderately concave.

Measurements in mm.

Pedicle valves,	Length	Brachial length	Mid-width	Hinge width	Height	Thickness
U.S.N.M. No. 116724a....	12.4	?	13.7	16.6	4.5	?
U.S.N.M. No. 116724b....	12.7	?	14.3	16.5	3.8	?
U.S.N.M. No. 116724d....	9.5	8.2	?	?	?	2.2

Types.—Holotype: U.S.N.M. No. 116724d; figured paratypes: U.S.N.M. Nos. 116724a-c, e-f.

Horizon and locality.—Signal Mountain formation (limestone one foot thick 126 feet above the base) in Oklahoma, 1,700 feet west and 600 feet south of the northeast corner of sec. 28, T. 1 S., R. 1 W., Murray County.

Discussion.—No other species of this genus is known to which *C. hami* can be compared.

Genus **MESONOMIA** Ulrich and Cooper, 1936

MESONOMIA MAGNA Cooper, new species

Plate 1D, figures 27-34

Shell large for the genus, subrectangular in outline with the hinge forming the widest part; cardinal extremities auriculate; sides nearly straight; anterior margin broadly rounded. Anterior commissure uniplicate. Ornamentation consisting of costellae of varying sizes alternating with each other.

Pedicle valve unevenly convex in lateral profile and with the maximum convexity in the umbonal region; anterior profile broadly convex. Umbo narrowly swollen and forming a narrow fold to about the valve middle; anterior part of the median portion bent fairly abruptly in the direction of the brachial valve and forming a short, narrowly convex tongue; flanks bounding sulcus gently swollen; slopes to the posterolateral extremities short and gentle. Interior with small teeth and moderately thickened adductor track.

Brachial valve gently convex in lateral profile and broadly but gently convex in anterior profile; umbo sulcate, sulcus shallow and continued anteriorly to about the middle where it suddenly reverses to form a moderately broad fold; flanks gently swollen; interior with short, delicate brachiophores supported by shallow plates that unite under the thin cardinal process. Median ridge short and delicate.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116694a.	12.3	?	15.0	15.8	3.3
Brachial valves, U.S.N.M. No. 116694b.	?	10.7	14.8	17.8	2.9
U.S.N.M. No. 116694c.	?	11.1	15.8	17.2	2.7

Types.—Holotype: U.S.N.M. No. 116694a; figured paratypes: U.S.N.M. Nos. 116694b-d.

Horizon and locality.—Fort Sill formation (179 feet above the base) in Oklahoma, 1,000 feet south of the north quarter corner of sec. 29, T. 1 S., R. 1 E., Murray County.

Discussion.—This species is distinguished by its large size, gently sulcate pedicle valve, and the nature of the ornamentation. The species is most like *M. iophon* (Walcott) from the Mons formation of Alberta but is much larger and with less pronounced fold and sulcus. The ornamentation of *M. iophon* is stronger than that of the Arbuckle species and is not so strongly differentiated into strong and fine costellae.

FASCICULINA Cooper, new genus

Exterior somewhat resembling *Aphcoorthis* and with unequally convex valves, the pedicle valve having the greater depth. Anterior commissure broadly sulcate; surface fascicostellate.

Pedicle valve with swollen median region serving as a fold; teeth small; dental plates well developed; muscle field orthoid and with the adductor track more or less elevated to form a pseudospondylium.

Brachial valve with sulcus originating at the beak and usually bounded by two strong costellae; cardinalia delicate; brachiophores short, small; sockets formed by small fulcral plates; brachiophore supports nearly erect to moderately oblique, attached directly to the floor of the valve but more or less joined by a callosity between them; cardinal process a simple ridge when present. Median ridge formed by inner swelling corresponding to sulcus; adductor callosities thick in old shells.

Genotype.—*Orthis desmopleura* Meek (as redefined by Ulrich and Cooper, Geol. Soc. Amer. Spec. Pap. 13, p. 131, 1938).

Discussion.—This genus can be recognized by its fasciculate exterior, usually weakly developed pseudospondylium, and discrete brachiophore plates. It may be easily confused with *Finkelburgia* when the brachiophore plates are strongly oblique, but it differs from that genus in having a much stronger sulcus, one that extends from beak to anterior margin, much stronger ornamentation and generally weaker development of the pseudospondylium.

Fasciculina is like *Orusia* internally but is much differently ornamented. Furthermore in that genus the dental plates are short and no trace of a pseudospondylium has been seen.

Other species besides the genotype assigned to *Fasciculina* are *Eoorthis wichitaensis* Walcott and possibly *E. indianola* Walcott.

FASCICULINA FASCICULATA Cooper, new species

Plate 2A, figures 1-7

Small, subquadrate in outline, wider than long, and with the hinge forming the widest part; sides slightly oblique; anterior margin broadly rounded; cardinal extremities slightly auriculate. Surface fascicostellate.

Pedicle valve evenly and moderately convex in lateral profile and with the maximum convexity at about the middle; anterior profile fairly strongly and broadly convex; umbo narrowly convex, the convexity extended to the anterior margin as a low and broad fold having a median costella at the umbo and extending to the margin but with a broad fascicle implanted on each side of it. Flanks gently swollen and separated from the fold by a strong costella on each side giving the appearance of a fold within a broad median sulcus. Pseudospondylium moderately thickened and with the adductor track slightly elevated.

Brachial valve gently convex in lateral profile and broadly and gently convex in anterior profile; sulcus originating at the umbo and widening rapidly to the front margin where it occupies about half the width; posterior of sulcus marked by two costellae which bound a deep median sulcus within the broad sulcus; broad sulcus bounded by a strong costella on each side, and these oppose the depressions bounding the pedicle fold and the deeper inner sulcus opposes the fold within the pedicle depression. Flanks bounding sulcus, narrow, gently swollen. Interior with short delicate brachiophores and recumbent brachiophore plates.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thick-ness
Pedicle valves, U.S.N.M. No. 116738a.....	6.4	?	7.9	7.9 plus	2.4
U.S.N.M. No. 116738b.....	7.1	?	8.6	8.9	2.3
Brachial valve, U.S.N.M. No. 116738d.....	?	5.7	7.8	8.1	1.7

Types.—Holotype: U.S.N.M. No. 116738e; figured paratypes: U.S.N.M. Nos. 116738b-d; unfigured paratype: U.S.N.M. No. 116738a.

Horizon and locality.—Signal Mountain formation (90 feet above the base) in Oklahoma, in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 1 S., R. 1 W., 1,200 feet west of the east quarter corner, Murray County.

Discussion.—This species can be recognized by its strong costellae, alate cardinal extremities, fairly deep sulcus, and fairly well-developed

pseudospondylium. It most resembles *F. desmopleura* (Meek) in its ornamentation but differs in its interior, the brachiophore supporting plates of the Arbuckle shell being more oblique and joined by a callus on the floor of the valve. Furthermore *F. fasciculata* has a moderately developed pseudospondylium whereas that of *F. desmopleura* is not strongly thickened.

This species differs from *F. wichitaensis* in being much smaller, having a more pronounced pedicle fold and stronger costellae.

Genus **FINKELBURGIA** Walcott, 1905

FINKELBURGIA ARBUCKLENSIS Cooper, new species

Plate 3H, figures 33-39

Shell of about medium size for the genus, wider than long; sub-rectangular in outline; sides nearly straight; hinge equal to or slightly narrower than the midwidth; cardinal extremities slightly obtuse or forming a right angle. Multicostellate with a few strong costellae standing out in a mat of fine ones.

Pedicle valve moderately convex in lateral profile but with the maximum curvature in the umbonal region; broadly and strongly convex in anterior profile; beak prominent; umbo and median regions swollen; flanks full with short steep slopes to the margins. Delthyrial cavity wide and deep; pseudospondylium with well-developed dental plates, narrow or broad adductor track but short median ridge. Pallial trunks wide and deeply impressed.

Brachial valve shallower than the pedicle valve, with gentle convexity in lateral profile and broadly convex in anterior profile. Sulcus poorly defined, shallow, extending from umbo to anterior margin; flanks gently swollen but median region somewhat flattened. Lateral slopes short and gentle. Interior with broad and short notothyrial cavity; adductor callosities not strongly developed but six pallial trunks deeply impressed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valves,					
U.S.N.M. No. 116741a.....	8.9	?	11.3	9.6	2.5
U.S.N.M. No. 116741b.....	8.0	?	10.3	10.3	2.2
Brachial valves,					
U.S.N.M. No. 116741c.....	?	8.8	12.0	10.5	2.3
U.S.N.M. No. 116741d.....	?	9.2	12.1	11.8	2.3

Types.—U.S.N.M. No. 116741b; figured paratypes: U.S.N.M. Nos. 116741a, c, d.

Horizon and locality.—McKenzie Hill formation (237 feet above the base) in Oklahoma, 1,500 feet east and 2,000 feet south of the northwest corner of sec. 28, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by subrectangular outlines nearly rectangular or slightly obtuse cardinal extremities, poorly defined sulcus and closely crowded costellae. The species suggests *F. bellatula* Ulrich and Cooper but that is a smaller and somewhat less transverse shell with stronger costellae and more delicate pseudospondylium. *Finkelburgia arbuclensis* is similar to *F. helleri* Cloud but differs in being less transverse and in having a finer ornament, stouter cardinalia, and a narrower pseudospondylium.

FINKELBURGIA AURICULATA Cooper, new species

Plate 2F, figures 29-38

Shell small, wider than long, and with the hinge wider than the midwidth; cardinal extremities mucronate; sides gently oblique; anterior margin broadly rounded; surface fascicostellate.

Pedicle valve deeper than the brachial valve; strongly convex in lateral profile; anterior profile strongly arched; umbo and median region strongly swollen; flanks swollen and with steep slopes to the margins. Interarea short, curved, apsacline. Interior with a deep pseudospondylium but with the adductor track only moderately thickened.

Brachial valve strongly convex in lateral profile; anterior profile strong and broadly convex and with steep lateral slopes. Umbo sulcate; sulcus widening and deepening anteriorly to the front margin. Flanks bounding sulcus fairly strongly swollen; brachiophores and supporting plates stout.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
U.S.N.M. No. 116731a.....	6.1	5.7	7.4	7.9	4.7
Pedicle valve,					
U.S.N.M. No. 116731c.....	5.7	?	7.0	8.0	2.1

Types.—Holotype: U.S.N.M. No. 116731a; figured paratypes: U.S.N.M. Nos. 116731c-f; unfigured paratype: U.S.N.M. No. 116731b.

Horizon and locality.—Signal Mountain formation (6-inch bed of limestone 150 feet above the base) in Oklahoma, 300 feet west and 1,150 feet south of the northeast corner of sec. 28, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by rectangular outline, strongly and subequally convex valves, and the sharp auriculation of the cardinal extremities. In the latter respect the species resembles *F. finkelnburgi* but it is much smaller and has straighter lateral margins and less extended cardinal extremities.

FINKELNBURGIA cf. **F. BELLATULA** Ulrich and Cooper

Plate 3G, figures 28-32

Finkelnburgia bellatula ULRICH AND COOPER, Journ. Paleontol., vol. 10, No. 7, p. 622, 1936; Geol. Soc. Amer. Spec. Pap. 13, p. 134, pl. 25C, figs. 9, 10, 13-28, 1938.

Shell of about medium size for the genus, roundly subelliptical in outline with the hinge shorter than the midwidth which is the widest part; sides well rounded; anterior margin broadly rounded; cardinal extremities obtuse. Multicostellate, costellae of different sizes.

Pedicle valve gently convex in lateral profile but moderately convex in anterior profile; beak moderately protruberant; umbo narrowly swollen; entire valve fairly strongly inflated and with long convex lateral slopes. Interior with pseudospondylium short and weakly developed.

Brachial valve less deep than the pedicle valve, moderately convex in lateral profile; broadly and moderately convex in anterior profile; median regions inflated but posterior and median portion marked by a shallow and narrow sulcus which does not reach the margin. Anteromedian region swollen and conforming with the convexity of the rest of the valve; lateral slopes short and steep; interior with thick, erect brachiophore supports and thick cardinal process. Adductor platforms moderately developed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116747a.....	8.4	?	10.1	7.0	2.2
Brachial valve, U.S.N.M. No. 116747b.....	?	7.6	9.8	6.8	2.1

Hypotypes.—U.S.N.M. Nos. 116747a, b.

Horizon and locality.—McKenzie Hill formation (10 feet below the top) in Oklahoma, 2,200 feet north and 1,250 feet west of the southeast corner of sec. 7, T. 1 S., R. 1 E., Murray County.

Discussion.—The specimens here assigned to *F. bellatula* agree in outline and profiles and the ornamentation is well differentiated as

in the type specimens. Furthermore the interiors agree in having a delicate pseudospondylium and the adductor platforms confined to the rear part of the shell.

FINKELNBURGIA BICONVEXA Cooper, new species

Plate 2E, figures 22-28

Shell of about medium size for the genus, wider than long, sub-rectangular in outline; hinge about equal to midwidth; cardinal extremities slightly auriculate; sides nearly straight; anterior margin broadly rounded; surface multicostellate, costellae crowded and of different sizes.

Pedicle valve deeper than the brachial valve, strongly convex in lateral profile; strongly convex in anterior profile and with long, steep, lateral slopes. Umbo, median region, and flanks strongly inflated. Pseudospondylium broad and low; adductor track thickened; median ridge short and thick.

Brachial valve moderately convex in lateral profile but broadly and strongly convex in anterior profile; beak prominent; umbo somewhat broadly and strongly swollen, the swelling continued anteriorly to the margin; anterior third somewhat flattened to approximate a median sulcus or definitely sulcate, the sulcus broad and shallow; flanks somewhat swollen and with short steep slopes to the margins. Interior with large and thick cardinalia; adductor platforms not developed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116733a.....	8.1?	?	9.3	8.6	2.9
Brachial valve, U.S.N.M. No. 116733f.....	?	6.8	9.3	8.6	2.3

Types.—Holotype: U.S.N.M. No. 116733a; figured paratypes: U.S.N.M. Nos. 116733c, e, f; unfigured paratypes: U.S.N.M. Nos. 116733b, d.

Horizon and locality.—Signal Mountain formation (218 feet above the base) in Oklahoma, 500 feet west and 750 feet south of the north-east corner of sec. 28, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by strongly convex valves, closely crowded costellae, and a thick pseudospondylium. It is quite unlike other known Upper Cambrian Finkelburgias except *F. osceola* which is larger and differently shaped, and *F. newtonensis*

(Weller) which is much smaller, less convex, and differently ornamented.

Of Canadian species this one is most like *F. wemplei* but differs in greater convexity, particularly of the brachial valve, and in having slight auriculations on the brachial valve.

FINKELNBURGIA CRASSICOSTELLATA Cooper, new species

Plate 1C, figures 22-26

Shells of intermediate size for the genus, wider than long, sub-rectangular in outline and with the hinge narrower than the maximum width which is at the middle; cardinal extremities obtuse; sides rounded; anterior margin broadly rounded; surface strongly costellate, costellae of unequal size.

Pedicle valve gently convex in lateral profile and with the most curvature just anterior to the middle; anterior profile moderately and broadly convex, umbo broadly swollen; median region gently convex; anterior half somewhat swollen and curved toward the brachial valve; flanks moderately swollen and with short, steep lateral slopes. Pseudospondylium broad and poorly developed; median ridge low and thick.

Brachial valve much less deep than the pedicle valve, gently convex in lateral and anterior profiles; umbo and median region gently swollen; sides gently swollen and with long, gentle, lateral slopes; interior with broadly recumbent brachiophore plates, and strong adductor callosities.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116726a.....	8.5	?	11.0	8.8	2.5
Brachial valve, U.S.N.M. No. 116726c.....	?	7.5	10.9	10.2	1.8

Types.—Holotype: U.S.N.M. No. 116726a; figured paratypes: U.S.N.M. Nos. 116726b, c.

Horizon and locality.—Kindblade formation in Oklahoma, in the center NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is characterized by strong costellae, a shallow brachial valve having large adductor platforms extending to about the middle and a fairly deep pedicle valve with broad, weakly developed pseudospondylium. The species suggests a small *F. magna* but it attains only about half the size of that species and also differs in the strength of its costellae. The interior of both valves is not so

extravagantly developed as that of *F. magna*, but the structures are of the same broad character.

FINKELNBURGIA DELICATULA Cooper, new species

Plate 2D, figures 16-21

Small for the genus, wider than long with the hinge less than or about equal to the midwidth; cardinal extremities slightly obtuse or approximating a right angle; sides nearly straight; anterior margin broadly rounded; surface finely and closely costellate, but with scattered strong costellae.

Pedicle valve moderately convex in lateral profile and with the maximum convexity in the posterior third; anterior profile strongly convex; umbonal and median regions swollen; flanks descending moderately steeply to the margins; anterior somewhat flattened; interior with well-defined pseudospondylium with thickened and elongated adductor track supported by a short stout median ridge.

Brachial valve not so deep as the pedicle valve and moderately convex in lateral profile, broadly and moderately convex in anterior profile. Umbo sulcate; sulcus narrow and shallow, defined from umbo to anterior margin; flanks swollen and with short, moderately steep lateral slopes. Interior with moderately well-developed adductor platforms.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116734a.....	7.6	?	9.0	8.8	2.5
Brachial valves, U.S.N.M. No. 116734f.....	?	6.1	8.3	7.8	2.0
U.S.N.M. No. 116734h.....	?	5.9	8.4	7.3	1.7

Types.—Holotype: U.S.N.M. No. 116734a; figured paratypes: U.S.N.M. Nos. 116734f, g; unfigured paratypes: U.S.N.M. Nos. 116734b-e, h.

Horizon and locality.—Upper Cool Creek formation in Oklahoma, one mile southeast of the windmill, center of sec. 5, T. 2 S., R. 1 E., Murray County.

Discussion.—Small size, fine costellae, subrectangular outline, and subauriculate cardinal extremities characterize this species. It is suggestive of *F. bellatula* in outline but has a somewhat wider hinge with definite auriculations and somewhat finer ornamentation. The interiors of the two species show differences. The muscle platforms of the brachial valve of *F. delicatula* occupy more of the interior than

those of *F. bellatula* and the pseudospondylium of the pedicle valve is stouter than that of *F. bellatula*.

FINKELNBURGIA EXTENSA Cooper, new species

Plate 2G, figures 39-51

Shell of about medium size for the genus, width of hinge equal to about twice the shell length; cardinal extremities mucronate; lateral margins concave just anterior to the cardinal extremity; anterior margin broadly rounded. Surface marked by crowded costellae of unequal size, the larger ones in the minority, but numbering three or four to a millimeter at the front margin.

Pedicle valve unevenly convex in lateral profile, with the maximum convexity just anterior to the umbo; anterior profile narrowly convex in the median region and with abrupt slopes steep on the flanks of the median area but gentle to the margins. Beak prominent and elevated; umbo narrow and convex; median region strongly swollen from umbo to anterior margin; interior with pseudospondylium having an extravagantly thickened adductor and median ridge; pallial trunks deeply entrenched.

Brachial valve slightly less deep than the pedicle valve and having a moderately convex lateral profile in which the maximum convexity is located just anterior to the umbo; anterior profile broadly and moderately convex. Sulcus narrow and shallow, originating on the umbo and extending to the anterior margin, widening only slightly in its passage anteriorly; flanks bounding sulcus fairly strongly swollen; lateral slopes short, moderately steep. Interior with deep sockets, short and blunt brachiophores and strong, thick brachiophore plates. Cardinal process thin and delicate. Adductor platforms not strongly thickened.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valves,					
U.S.N.M. No. 116728b.....	6.8	?	8.8	13.3	2.9
U.S.N.M. No. 116728g.....	8.9	?	12.2	18.9 +	4.0
U.S.N.M. No. 116728h.....	7.2	?	7.9	12.0	2.6
Brachial valves,					
U.S.N.M. No. 116728a.....	?	6.3	8.1	11.0	2.1
U.S.N.M. No. 116728d.....	?	6.5	9.1	12.7	2.2
U.S.N.M. No. 116728f.....	?	5.9	8.7	13.4	1.9

Types.—Holotype: U.S.N.M. No. 116728b; figured paratypes: U.S.N.M. No. 116728a, d-g, j; unfigured paratypes: U.S.N.M. Nos. 116728c, h, i, k.

Horizon and locality.—Signal Mountain (90 feet above the base)

in Oklahoma, SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 1 S., R. 1 W., 1,200 feet west of the east quarter corner, Murray County; 70 feet above the base, 2,300 feet west and 1,700 feet north of the southeast corner of sec. 8, T. 1 S., R. 1 W., Murray County.

Discussion.—This species is unusual for the great extension of its cardinal extremities and the deep impression of the pallial channels on the inside of the valves. It is most like the type species of *Finkelburgia*, *F. finkelburgi* Walcott, in the great extension of the cardinal extremities but is more extreme in this respect than any figured specimens of that species. *Finkelburgia extensa* differs from *F. finkelburgi* also in having finer ornamentation.

FINKELBURGIA OBESA Cloud

Plate 3F, figures 20-27

Finkelburgia obesa CLOUD, Bull. Mus. Comp. Zool., vol. 100, No. 5, p. 458, pl. 1, figs. 8-18, 1948.

Shell of intermediate size for the genus, wider than long, suboval in outline with the hinge narrower than the greatest width which is just anterior to the middle; cardinal extremities obtuse; sides rounded; anterior margin broadly rounded. Surface multicostellate.

Pedicle valve moderately convex in lateral profile but with the maximum convexity in the umbonal region. Anterior profile broadly convex; beak prominent; umbo somewhat narrowly swollen but the swelling not continued to the middle; median region and flanks gently swollen; anterior half somewhat depressed to form a poorly defined sulcus. Interior with prominent and well-developed pseudospondylium having an elevated adductor track and a moderately high median septum.

Brachial valve gently convex in lateral profile and not having as much depth as the pedicle valve; anterior profile broadly and gently convex. Umbonal, median and flank regions swollen; lateral slopes short and steep. Interior with brachiophore plates stout and well-defined; cardinal process a thin ridge; adductor platforms moderately developed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valves,					
U.S.N.M. No. 116745a.....	9.5	?	11.4	6.9	2.8
U.S.N.M. No. 116745b.....	9.3	?	10.6	8.6	2.7
Brachial valves,					
U.S.N.M. No. 116745c.....	?	10.4	11.6	8.7	3.0
U.S.N.M. No. 116745d.....	?	8.9	11.5	8.0	2.4
U.S.N.M. No. 116745e.....	?	8.4	10.5	7.2	2.3

Types.—Figured hypotypes: U.S.N.M. Nos. 116745b-e; unfigured hypotype: U.S.N.M. No. 116745a.

Horizon and locality.—McKenzie Hill formation (35 feet below the top) in Oklahoma, 2,200 feet east and 2,500 feet north of the southwest corner of sec. 2, T. 2 S., R. 1 E., Murray County.

Discussion.—Comparison of the McKenzie Hill specimens with Cloud's types of *F. obesa* indicates the exterior form to be very close. Comparison of the ornamentation is not possible in detail because the specimens from Oklahoma and Texas are badly worn. Those of the Arbuckle species were undoubtedly considerably water-worn before silicification. Details of the interior of the Texas species are not well preserved, but those that can be seen show close resemblance except for the fact that the Oklahoma specimens are somewhat thicker.

FINKELNBURGIA SUBQUADRATA Cooper, new species

Plate 3I, figures 40-45

Shell large for the genus; wider than long and with the hinge slightly wider than the midwidth; cardinal extremities slightly auriculate; sides gently rounded; anterior margin broadly rounded. Surface strongly costellate, costellae of unequal size.

Pedicle valve considerably deeper than the brachial valve, strongly convex in lateral profile and with the maximum convexity in the umbonal region and just anterior thereto; anterior profile moderately and broadly convex. Beak small, slightly protruberant. Umbo swollen; median region from umbo to anterior margin swollen; flanks swollen and with short steep slopes to the margins. Pseudospondylium broad and with a long tonguelike adductor track; median ridge short and thick. Pallial sinuses (vascula media) wide and strongly divergent.

Brachial valve moderately convex in lateral profile; broadly and moderately convex in anterior profile. Umbo marked by a short, shallow sulcus; umbo and median region swollen, the swelling reflected in the flanks; lateral slopes moderately short and moderately gentle. Interior with small notothyrial chamber bounded by short brachiophore plates. Adductor callosities modestly developed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116743a....	12.8	?	15.5	14.7 plus	4.0
Brachial valve, U.S.N.M. No. 116743b....	?	10.2	13.7	13.6	3.0

Types.—Holotype: U.S.N.M. No. 116743a; paratype: U.S.N.M. No. 116743b.

Horizon and locality.—Cool Creek formation in Oklahoma, 900 feet west and 1,450 feet north of the southeast corner of sec. 3, T. 2 S., R. 1 W., Murray County.

Discussion.—This species can be recognized by its large size, subquadrate outline, strong costellae, thick and elevated pseudospondylium, and the broad, divergent pallial marks in the pedicle valve. *Finkelburgia subquadrata* most strongly resembles *F. virginica* but is somewhat larger, is more quadrate, and has more distant costellae. Inside the brachial valve the adductor platforms of *F. virginica* are scarcely developed but in the Arbuckle shell they are strong. Inside the brachial valve the deep and wide vascula media are a feature peculiar to the Oklahoma species.

Genus PLECTOTROPHIA Ulrich and Cooper, 1936

PLECTOTROPHIA LATICOSTA Cooper, new species

Plate 4E, figures 23-35

Shell of about usual size for the genus, wider than long, subrectangular in outline; sides gently oblique to gently rounded; hinge slightly wider or slightly less than the midwidth depending on age; cardinal extremities slightly obtuse or slightly auriculate; anterior commissure gently uniplicate; surface marked by distant, rounded, elevated costellae crossed by prominent concentric lines of growth.

Pedicle valve unevenly convex in lateral profile and with the maximum convexity between the umbo and the middle, the anterior half flattened. Anterior profile with the median region somewhat narrowly convex and with steep sides. Beak small, umbo narrowly convex; posteromedian region swollen and with steep slopes to the cardinal extremities. Sulcus originating just anterior to the umbo, deepening and widening near the middle. Anterior tongue short and bluntly rounded. Interior with long and narrow pseudospondylium tapering anteriorly to a sharp point; median septum only slightly developed. Pallial marks not deeply impressed.

Brachial valve gently convex in lateral profile and with the maximum depth located just anterior to the umbo; anterior profile broadly, fairly evenly and moderately convex. Beak small, umbo somewhat narrowly swollen; median region broadly and strongly swollen; posterior marked by a short, shallow depression just anterior to the umbo, which is followed by the fold; fold originating just posterior to the middle, widening anteriorly, low and broadly rounded through-

out. Flanks bounding fold gently swollen and with long gentle slopes to the margins. Interior with short brachiophores supported by short convergent supporting plates.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 117951d.....	8.5	?	10.9	11.3	2.2?
Brachial valve, U.S.N.M. No. 117951b.....	?	8.1	12.7	11.4	3.7
U.S.N.M. No. 117951g.....	?	7.6	11.5	10.2?	2.3

Types.—Holotype: U.S.N.M. No. 117951g; figured paratypes: U.S.N.M. Nos. 117951a-f; unfigured paratypes: U.S.N.M. Nos. 117951h-k.

Horizon and locality.—Fort Sill formation (150 feet above the base) in Oklahoma, 2,500 feet east and 2,200 feet north of the southwest corner of sec. 26, T. 2 S., R. 4 E., South Ranch, Johnston County.

Discussion.—This species is especially characterized by its strong costellae, the low and broad fold, and the short blunt tongue of the pedicle valve. When compared with *P. bridgei* the Oklahoma specimens have a much less-elevated and less-carinate fold, a shallower sulcus on the pedicle valve, and a much shorter, blunter tongue on the pedicle valve. Inside the pedicle valve the pseudospondylium of *P. bridgei* is more elevated, has subparallel sides and a narrowly rounded front, whereas the same structure in *P. laticosta* is long, slender, tapers to a point, and is low throughout its extent.

Genus **TETRALOBULA** Ulrich and Cooper, 1936

TETRALOBULA TEXANA Ulrich and Cooper

Plate 4A, figures 1-7

Tetralobula texana ULRICH and COOPER, Geol. Soc. Amer. Spec. Pap. 13, p. 209, pl. 43B, figs. 17-22, 1938.—CLOUD, Bull. Mus. Comp. Zool., vol. 100, No. 5, p. 462, pl. 2, figs. 15-16, 21, 22, 1948.

A few well-preserved specimens of this species are illustrated to show the occurrence of this easily recognized genus in Oklahoma. The species is characterized by its low fold which is located at the anterior margin only. In the pedicle valve the sulcus is broad and shallow and the tongue broad and rounded. In young specimens little trace of the fold can be detected.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 117950e.....	8.7	?	11.0	8.5	3.0
Brachial valve, U.S.N.M. No. 117950f.....	?	7.4	9.8	7.3	2.2

Figured specimens.—U.S.N.M. Nos. 117950a-f.

Horizon and locality.—McKenzie Hill formation (about 250 feet above the base) in Oklahoma, 2,100 feet west and 1,500 feet north of the southeast corner of sec. 36, T. 1 S., R. 1 E., Murray County.

Genus PALAEOSTROPHIA Ulrich and Cooper, 1936

PALAEOSTROPHIA cf. P. ELAX (Clark)

Plate 3A, figures 1, 2

Syntrophia elax CLARK, Bull. Amer. Paleontol., vol. 10, No. 41, p. 15, pl. 3, fig. 1, 1924.

Palaeostrophia elax (Clark) ULRICH and COOPER, Geol. Soc. Amer. Spec. Pap. 13, p. 195, pl. 41A, figs. 1-11, 15, 1938.

Shell of about usual size for the genus, represented by three fragmentary specimens. Pedicle valve with wide and shallow sulcus occupying most of anterior region. Brachial valve with a broadly rounded fold. Interior with characteristic erect brachiophore supporting plates and elongate adductor tracks.

Figured specimens.—U.S.N.M. Nos. 116751a, b.

Horizon and locality.—Signal Mountain formation (63 feet below the top) in Oklahoma, 1,500 feet west and 1,900 feet north of the southeast corner of sec. 6, T. 2 S., R. 2 E., Murray County.

Genus GLYPTOTROPHIA Ulrich and Cooper, 1936

GLYPTOTROPHIA ROTUNDA Cooper, new species

Plate 2C, figures 14, 15

Small, transversely but broadly elliptical in outline; sides rounded; anterior commissure strongly uniplicate; surface marked by fine costellae cancellated by strong concentric lamellae.

Pedicle valve gently convex in lateral profile and strongly but broadly convex in anterior profile. Beak projecting; umbo narrowly rounded; median region swollen. Sulcus originating just posterior to the middle, deepening anteriorly but shallow throughout its length. Tongue short and narrowly rounded. Flanks swollen near the median

region and with long steep slopes to the margins. Interior with broad, short sessile spondylium.

Brachial valve gently convex in lateral profile; broadly convex in anterior profile with the median region somewhat carinated and with long lateral slopes; umbo narrow and protuberant; median region inflated gently; fold originating at about the middle, low and subcarinate; flanks gently swollen. Interior with short, shallow brachiophore plates.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116740b.....	6.3	?	8.1	6.8	2.2
Brachial valve, U.S.N.M. No. 116740d.....	?	5.4	7.8	6.0	2.2

Types.—Holotype: U.S.N.M. No. 116740b; figured paratype: U.S.N.M. No. 116740d; unfigured paratypes: U.S.N.M. Nos. 116749a, c, e.

Horizon and locality.—Signal Mountain formation (2-3½ feet above base of Butterly dolomite) in Oklahoma, SW¼SW¼SW¼ sec. 9, T. 2 S., R. 2 E., Murray County.

Discussion.—This species is ornamented like *G. imbricata* from the Mons formation near Lake Louise, Alberta, but differs in its less-transverse outline, less-deep pedicle sulcus, and more narrowly rounded fold on the brachial valve.

IMBRICATIA Cooper, new genus

Shells usually transverse, syntrophoid in profile and outline; anterior commissure moderately uniplicate; surface marked by strong concentric imbrications and fine costellae.

Interior of pedicle valve with small teeth and usually with a thick spondylium simplex, sessile at the rear but elevated anteriorly and supported by a short thick median ridge. Vascula media usually strongly developed.

Brachial valve with short, stout brachiophores and small sockets defined by small fulcral plates. Brachiophore supporting plates usually erect to moderately oblique, meeting the floor of the valve; brachiophore plates usually with thick ridges near the base of the plate which give them a saucerlike shape; no cardinal process. Adductor scars as in *Tetralobula* but usually not with strong callosities.

Genotype.—*Imbricatia lamellata* Cooper, new species.

Discussion.—This genus is essentially like *Tetralobula* but differs

in having a more elaborate ornamentation which consists of fine radial costellae interrupted by strong concentric lamellae. Internally the two genera are similar but differ in details of the brachial interior. The brachiophore supporting plates are alike and were evidently the seat of attachment for diductor muscles. This is clearly shown by the presence of strong curving ridges near their base which gives them a saucerlike appearance. The adductor callosities of *Imbricatia* are not so strongly developed as those of *Tetralobula*.

Imbricatia is ornamented like *Stichtrophia* but differs from that genus in having brachiophore plates convergent toward the floor of the valve rather than strongly divergent. In *Stichtrophia*, furthermore, the brachiophore plates have adductor ridges suggestive of *Imbricatia* but they appear high above the floor so that the plate seems to consist of two elements. *Calliglypha* Cloud has imbricate ornamentation but in that genus the imbrications and radial lines produce small spines. Cloud's genus is readily differentiated internally because it is like *Diaphelasma*.

Other species formerly placed in *Tetralobula* can be assigned to *Imbricatia* as follows: *Imbricatia coloradoensis* (Ulrich and Cooper) from the Manitou limestone of Colorado; *I. imbricata* (Ulrich and Cooper) from the Hastings Creek formation near Philipsburg, Quebec; and probably *Tetralobula dorsosulcata* (Ulrich and Cooper) also from the Manitou limestone of Colorado.

IMBRICATIA LAMELLATA Cooper, new species

Plate 3E, figures 14-19; plate 4D, figures 17-22

Shell of about medium size for the genus, wider than long, roundly elliptical in outline; hinge wide; posterolateral extremities narrowly rounded; sides rounded; anterior margin broadly rounded; anterior commissure gently uniplicate; surface with strong concentric plaits which are finely costellated; costellae about eight in one millimeter at the front margin.

Pedicle valve moderately convex in lateral profile with the maximum convexity in the anterior half; anterior profile broadly and moderately convex, umbo and median region swollen; sulcus shallow, originating at about the middle; tongue short and narrowly rounded. Interior with spondylium sessile at rear but strongly elevated anteriorly; old shells with pallial marks strongly developed.

Brachial valve moderately convex in lateral profile, broadly and moderately convex in anterior profile. Fold variable, defined in the front third only and often appearing as an emargination in the an-

terior margin. Median region swollen; flanks moderately convex and with moderate slopes.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valves,					
U.S.N.M. No. 116752b.....	8.7	?	10.4	9.0	2.4
U.S.N.M. No. 116752c.....	7.2	?	8.6	7.6	2.2
Brachial valves,					
U.S.N.M. No. 116752e.....	?	7.6	10.6	8.4	2.8
U.S.N.M. No. 116752g.....	?	8.2	10.9	7.5	3.0

Types.—Holotype: U.S.N.M. No. 116752g; figured paratypes: U.S.N.M. Nos. 116752a, b, 117949a-c; unfigured paratypes: U.S.N.M. Nos. 116752c-f, h.

Horizon and locality.—Middle of Cool Creek formation in Oklahoma, 100 feet north and 50 feet east of southwest corner of sec. 34, T. 1 S., R. 1 W., Murray County.

Discussion.—This species suggests *I. coloradoensis* and *I. imbricata* but differs from both of them. From the former it may be distinguished by its more transverse outline and less sharply folded brachial valve. It is closer to *I. imbricata* of Quebec in outline but is also somewhat more transverse than the species and has a much less conspicuous and shorter sulcus in the pedicle valve and a usually more modest development of the brachial fold.

Genus **SYNTROPHINA** Ulrich, 1928

SYNTROPHINA CAMPBELLI (Walcott)

Plate 3C, figures 4-8

Syntrophina campbelli WALCOTT, Smithsonian Misc. Coll., vol. 53, pp. 107, 108, pl. 10, figs. 9, 9a-c, 1908; U. S. Geol. Surv. Mon. 51, p. 801, fig. 73, 1912.

Syntrophina campbelli (Walcott) ULRICH and COOPER, Geol. Soc. Amer. Spec. Pap. 13, p. 218, pl. 46E, figs. 10-34, 1938.—CLOUD, Bull. Mus. Comp. Zool., vol. 100, No. 5, p. 462, pl. 2, figs. 10-13, 17, 1948.

Shell small, roundly elliptical in outline, and with the maximum width at about the middle; sides strongly rounded; anterior commissure gently rounded, strongly uniplicate. Surface marked by concentric lines of growth.

Pedicle valve moderately convex in lateral profile and broadly and moderately convex in anterior profile. Umbonal and median region swollen; sulcus originating at about the middle, broad and shallow. Tongue moderately long and narrowly rounded. Flanks bounding sulcus gently convex and with long steep slopes to the margins.

Spondylium small, short, and supported by a short median septum. Teeth small, long, narrow.

Brachial valve about equal in depth to the pedicle valve, gently convex in lateral profile and most convex in the umbonal region; anterior profile broadly and moderately convex. Umbonal region swollen; fold originating at about the middle, low and broadly rounded; flanks bounding fold gently swollen and with steep slopes to the margins. Interior with broad and short brachiophores supported by convergent plates that meet the floor of the valve in close proximity. Sockets defined by small socket plates. Adductor scars not impressed.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 116749a.....	7.1	?	10.4	5.5	2.5
Brachial valve, U.S.N.M. No. 116749g.....	?	7.5	8.8	4.4	3.0

Types.—Figured hypotypes: U.S.N.M. Nos. 116749d-f; unfigured paratypes: U.S.N.M. Nos. 116749a-c, g-i.

Horizon and locality.—McKenzie Hill formation (360 feet above the base) in Oklahoma, 950 feet west and 2,050 feet north of the southwest corner of sec. 26, T. 6 N., R. 14 W., Kindblade Ranch, Wichita Mountains, Kiowa County.

Discussion.—These specimens are unusual in being preserved as silicified shells. Hitherto this species was known only from chert impressions. The specimens herein illustrated conform to the details of the species except for the small transverse plate in the apex of the brachial valve. This is lacking from the Oklahoma specimens.

Genus **CLARKELLA** Walcott, 1908

CLARKELLA species

Plate 3B, figure 3

The specimens of this interesting genus reported for the first time in Oklahoma are unfortunately very fragmentary. Part of a pedicle valve indicates a species with a deep and wide median sulcus having a prominent, impressed line running down the middle; the tongue is long and pointed. The spondylium is strongly elevated on a high median septum. The brachial valve had a prominent fold but its prominence did not arise until the anterior part of the shell. The posterior half is well rounded and without a fold. The interior shows

the adductor callosities elevated on septa as usual for the genus, and the diductor ridges just below the notothyrial edge are well developed.

Figured specimen.—U.S.N.M. No. 116750a.

Horizon and locality.—Upper Cool Creek formation (300 feet below the top) in Oklahoma, at the south end of Falls Creek anticline, 2,200 feet north and 2,200 feet west of the southeast corner of sec. 21, T. 2 S., R. 2 E., Carter County.

Genus *DIPARELASMA* Ulrich and Cooper, 1936

DIPARELASMA COSTELLATUM Cooper, new species

Plate 3D, figures 9-13

Shell small, subcircular in outline with sides and anterior margins rounded; hinge narrow and cardinal extremities obtuse; surface costellate, three or four costellae to the millimeter at the front margin, the stronger ones concentrated at the sulcus.

Pedicle valve moderately convex in lateral profile and with the maximum convexity just anterior to the umbo; anterior profile strongly convex and with the median region somewhat narrowly rounded. Umbo narrowly swollen; median region swollen; anterior regions somewhat flattened; flanks sloping moderately steeply to the sides. Delthyrial cavity wide, bounded by strong dental plates.

Brachial valve having less depth than the pedicle valve and gentle convexity in lateral profile; anterior profile broadly and gently convex; umbo swollen and median and anterior regions moderately inflated; sulcus originating on the umbo, narrow and shallow, extending to the anterior margin. Flanks gently swollen; lateral slopes gentle.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thick-ness
Pedicle valve, U.S.N.M. No. 116754a.....	6.3	?	7.6	5.0	2.3
Brachial valve, U.S.N.M. No. 116754b.....	?	6.0	7.6	4.9	1.2

Types.—Holotype: U.S.N.M. No. 116754a; figured paratypes: U.S.N.M. Nos. 116754b, c.

Horizon and locality.—West Spring Creek formation (419 feet below the top) in Oklahoma, 1,400 feet east and 1,700 feet north of the southwest corner of sec. 6, T. 3 S., R. 4 E., Johnston County.

Discussion.—This species is characterized by small size, moderate convexity, and fairly strong costellae. The species is most like *D.*

typicum of described species but is smaller, less convex, and more strongly costellate particularly in the median region.

DIPARELASMA FASCICULATUM Cooper, new species

Plate 4B, figures 8-12

Shell of about usual size for the genus, subcircular in outline; sides and anterior margin rounded; hinge narrower than the greatest shell width which is at the middle. Anterior commissure slightly sulcate. Surface costellate, fasciculate in bundles of two to four costellae.

Pedicle valve moderately convex in lateral profile and with the maximum convexity just anterior to the umbo, the remainder of the valve more gently convex; anterior profile narrowly convex in the median region and with steep lateral slopes. Umbonal and median regions swollen, the swelling extending anteriorly to the front margin to form a faint fold. Interior with dental plates well developed.

Brachial valve gently convex in lateral profile and with the maximum convexity just anterior to the umbo; anterior profile gently and broadly convex but with the median region slightly depressed. Umbo moderately swollen; sulcus originating just anterior to the umbo, shallow, widening anteriorly but remaining shallow throughout, and occupying about half the width at the front margin. Tongue short, broadly rounded; flanks bounding sulcus slightly swollen and with gentle slopes to the margins. Interior with short and delicate brachiophore plates and short, low median ridge.

Measurements in mm.

	Length	Brachial length	Mid-width	Hinge width	Thickness
Pedicle valve, U.S.N.M. No. 117948a.....	6.7	?	6.9	4.9	2.3
Brachial valve, U.S.N.M. No. 117948b.....	?	6.8	8.2	5.7	1.6

Types.—Holotype: U.S.N.M. No. 117948b; paratype: U.S.N.M. No. 117948a.

Horizon and locality.—Upper Kindblade formation (about 250 feet below the top) in Oklahoma, 700 feet east and 1,200 feet south of the northwest corner of sec. 5, T. 3 S., R. 4 E., Johnston County.

Discussion.—This species is characterized by its fasciculate costellae and the short brachiophore plates. It differs from *D. costellatum* in having the finer costellae concentrated in the sulcus and in having much more delicate cardinalia. It differs from all other described species in its fasciculate ornamentation.

POLYTOECHIA SUBCIRCULARIS Cooper, new species

Plate 4C, figures 13-16

Shell wider than long, circular in outline and with the hinge narrower than the greatest shell width which is at the middle; sides gently rounded; anterior commissure rectimarginate; surface multicostellate, seven costellae in one millimeter at the anterior margin.

Pedicle valve fairly evenly convex in lateral profile and with the maximum convexity at about the middle; anterior profile strongly convex; beak small, narrowly swollen; umbo somewhat narrowly swollen; median region inflated and most strongly convex near the center; sides steeply sloping to the margins; anterior slope long and less steep than the lateral slopes. Interarea long, curved, apsacline. Interior with strong dental plates, erect and subparallel; muscular area slightly elevated above the floor of the valve; diductor scars elongate; adductor region marked by a long narrow groove bounded by two plates convergent with the median septum and extending anterior to the delthyrial cavity. Dental plates extended as slightly divergent ridges anteriorly to the anterior end of the median septum. Pallial trunks not clearly defined anterior to the ends of the extensions of the dental plates.

Brachial valve with evenly and moderately convex lateral profile; anterior profile broadly and moderately convex; valve broadly elliptical in outline; umbo and median regions strongly swollen; lateral slopes steep and moderately long; anterior slope long, gently rounded and less steep than the lateral slopes. Interior with short convergent brachiophore plates, small cardinal process, short median ridge but lightly impressed pallial and muscular marks.

Measurements in mm.

Pedicle valves,	Length	Brachial length	Mid-width	Hinge width	Thickness
U.S.N.M. No. 117952a.....	8.2	?	9.2	6.7	3.2
U.S.N.M. No. 117952c.....	?	7.7	10.9	7.8	2.4

Types.—Holotype: U.S.N.M. No. 117952a; figured paratypes: U.S.N.M. Nos. 117952b, c; unfigured paratypes: U.S.N.M. Nos. 117952d-f.

Horizon and locality.—West Spring Creek formation (598 feet above the base) in Oklahoma, on Joins Ranch, 750 feet west and 1,550 feet south of the northeast corner of sec. 9, T. 2 S., R. 1 W., Murray County.

Discussion.—This species is characterized by its nearly circular

pedicle valve, somewhat narrowly elliptical brachial valve, very fine costellae, and the low triseptate spondylium in the pedicle valve. This species suggests *P. alabamensis* and *P. fillistriata* in its fine costellae but differs from the former in being smaller, having a longer interarea which is less curved and a much lower spondylium. The Oklahoma species differs from *P. fillistriata* in having somewhat finer ornamentation and an extremely low spondylium, that of the Newala shell being strongly elevated.

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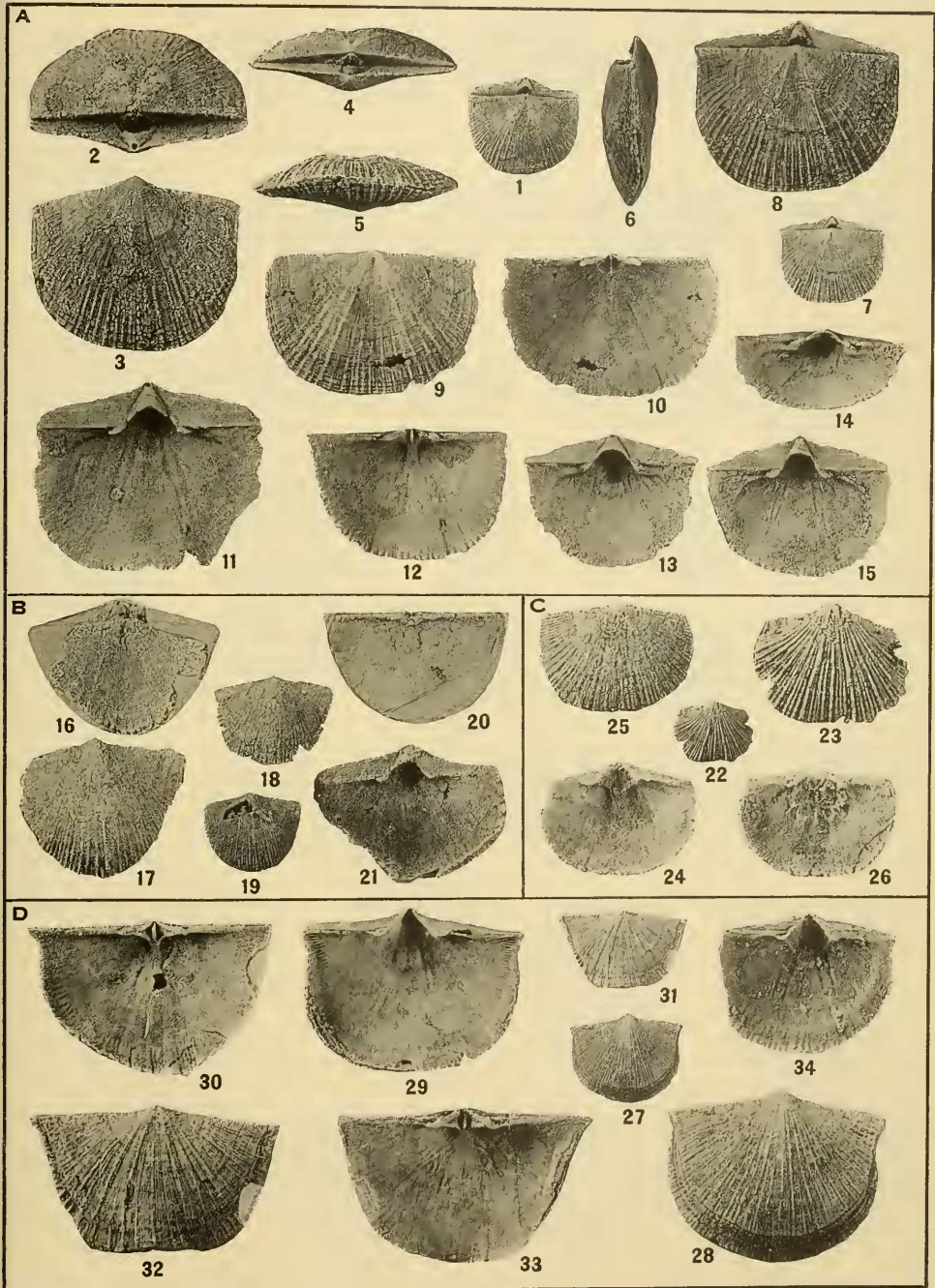
McKenzie Hill formation (about 250 feet above the base), 2,100 feet west and 1,500 feet north of the southeast corner of sec. 36, T. 1 S., R. 1 E., Murray County, Okla.

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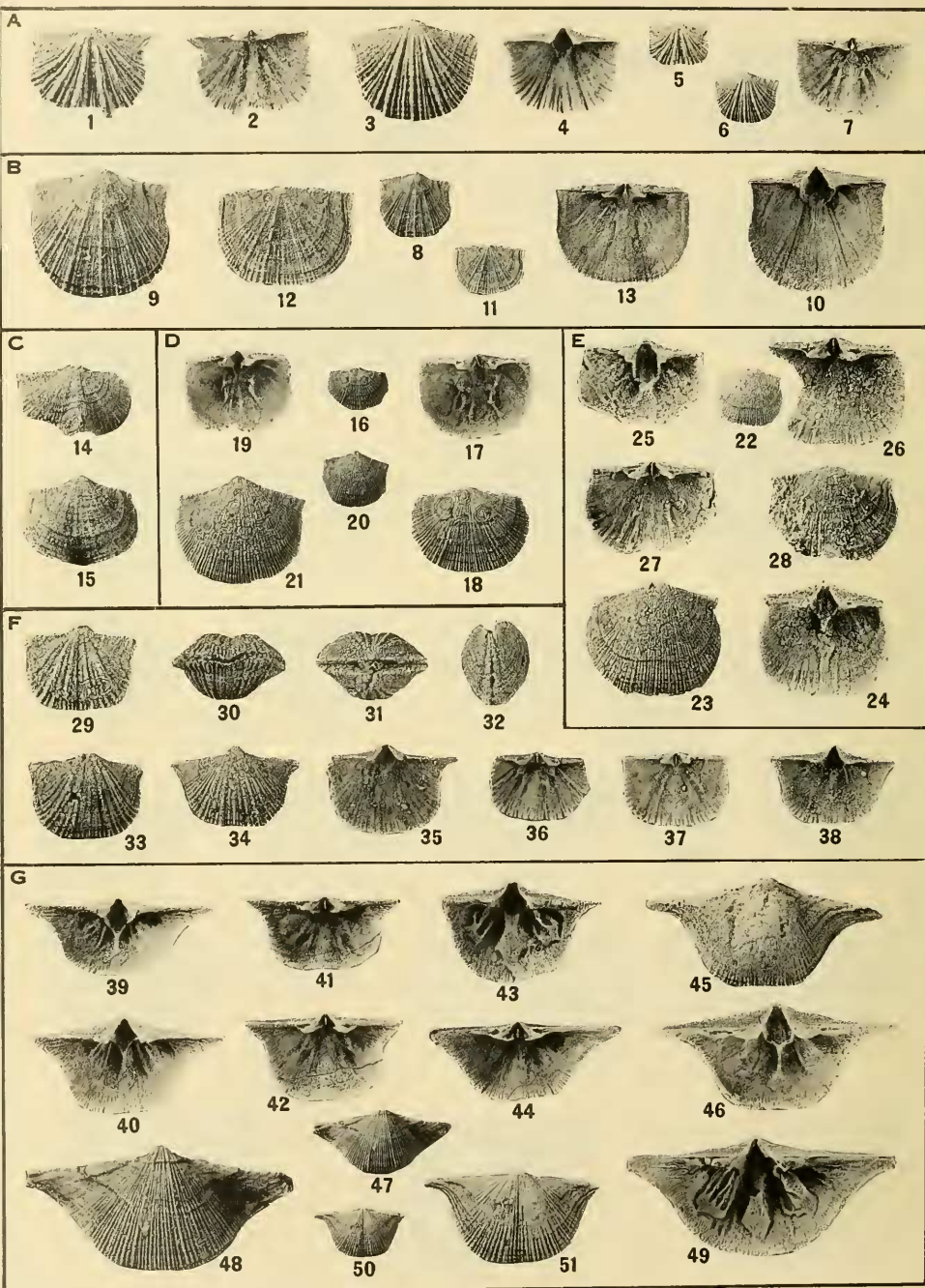
Upper Kindblade formation (250 feet below the top), 700 feet east and 1,200 feet south of the northwest corner of sec. 5, T. 3 S., R. 4 E., Johnston County, Okla.

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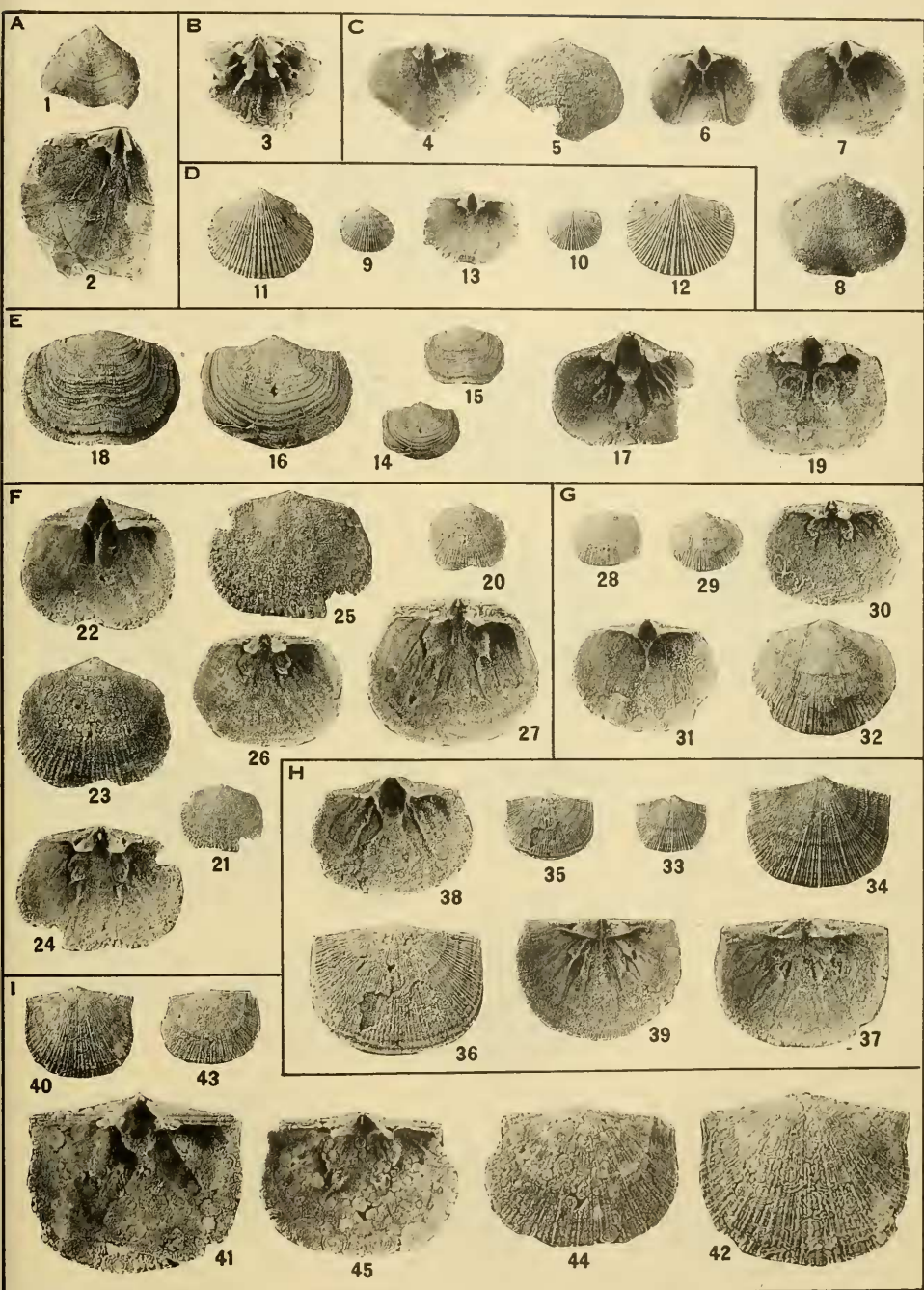
BRACHIOPODS FROM THE ARBUCKLE GROUP, OKLAHOMA

(SEE EXPLANATION OF PLATES AT END OF TEXT.)



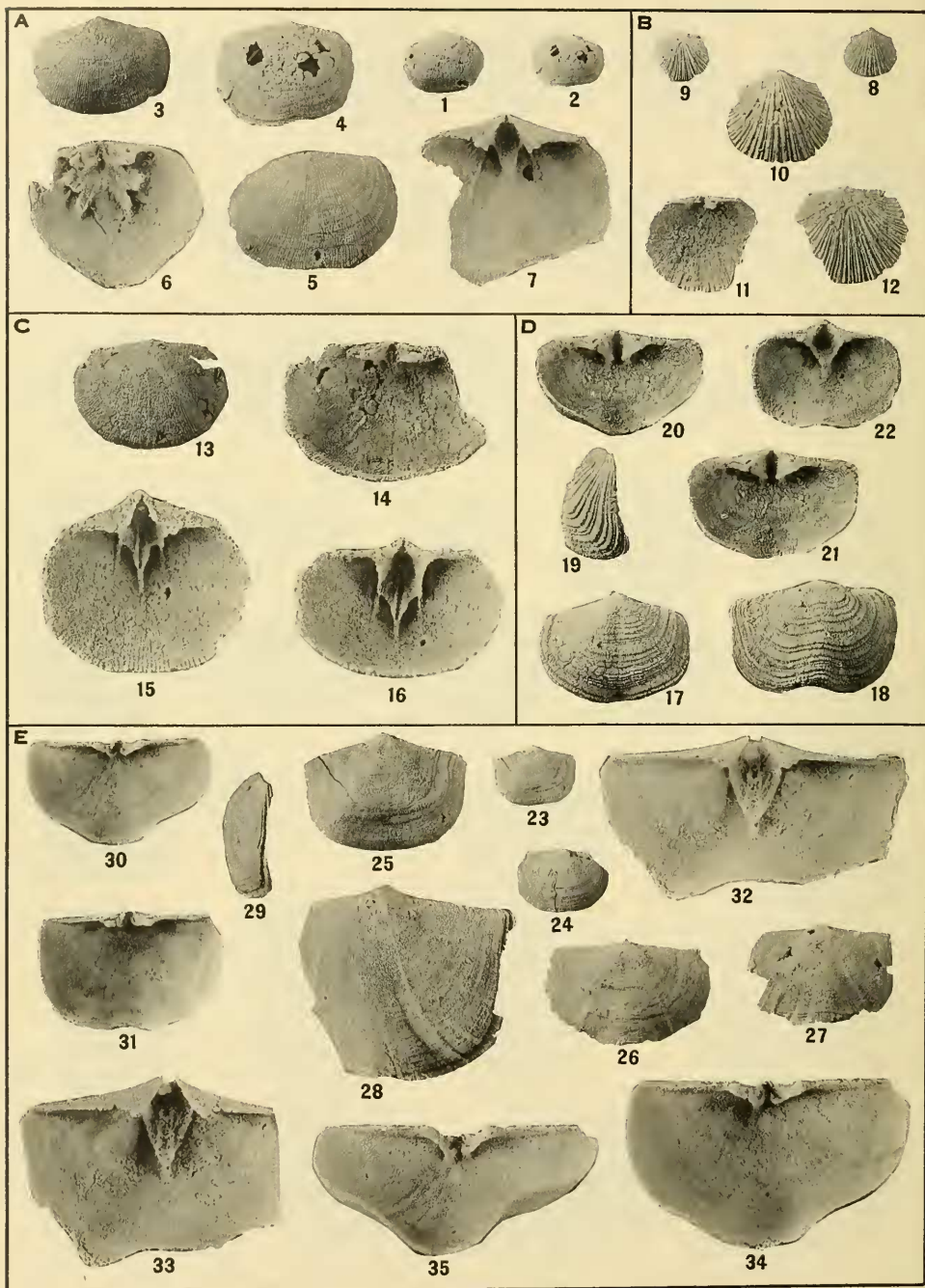
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